



THE CARDON MANAGEMENT GROUP
1841 EASTON AVENUE, BETHLEHEM, PA 18017

Hill Rivkins & Hayden LLP
45 Broadway, Suite 1500
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July 1, 2004

Dear Sirs:

SUBJECT: Boom Hoist - Motor Vessel Leon I

On October 8, 2003, at the request of Hill Rivkins & Hayden, I traveled to Annapolis, Maryland USA for the purpose of examining of a length of wire rope stored there. I had been retained to provide an opinion based upon my personal examination. It was my understanding that I would be examining a wire rope that had failed during service as the boom hoist line on a fixed shipboard crane mounted on the Leon I during an accident that had occurred on July 28, 2000.

My qualifications for making wire rope observations of this kind, including a list of my publications, are shown in Attachment A. The purpose of my visit was to make observations about the condition of the wire rope based on detailed visual examination. In this report, my use of the correct and accepted industry terminology has been implemented, containing the following defined words:

- wire = the individual elements from which a wire rope is manufactured.
- strands = elements comprised of wires placed in specific spatial relationship around a core by rotating machinery.
- core = the central part of a wire rope (usually comprised of another smaller rope, either fiber or metal) which supports the strands.
- wire rope = the flexible, load-bearing combination of strands with a core.

[Note: I have inserted this glossary because in the field there is a tendency to use the word "strand" to mean a single wire, and to use the word "wire" to mean a wire rope.]

All the visual observations I made on the wire rope were conducted in accord with established industry examination procedures described in reference documents such as the *Wire Rope Users Manual*, and also contained in various Federal OSHA documents (e.g. *Mobile Crane Inspection Guidelines for OSHA Compliance Officers - June '94*) that have been derived from information such as that provided in the *Wire Rope Users Manual*, which is currently published and distributed by the Wire Rope Technical Board, Alexandria, Virginia.

Upon arrival at the storage facility, I was taken to a room where several pallets loaded with coils of six-strand wire rope were stacked against a wall. The storage area was relatively clean and dry, implying that there had been little, if any, additional deterioration during several years of storage. No conventional wire rope handling equipment was available. As the wire rope was approximately one inch in diameter, a



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size that is usually manipulated easily by hand, I requested permission to uncoil all of it outdoors on a nearby paved street so as to be able to examine the entire length closely in bright sunlight.

During the unraveling process, I began to recognize specific attributes of the wire rope. It was immediately apparent to me, when the point of failure had been unraveled, that the wire rope I was examining was a six strand wire rope containing a fiber core. The two ends at the point of failure were easily located due to their distinctive appearance. After the wire rope had been arranged in the sunlight on the paved street, into a semblance of its original relationship, I next attempted to examine the entire length of it as minutely as possible, using a magnifying glass on occasion. At several places, other than the point of failure I also removed exterior lubricant to be able to better assess the condition of the wires.

During this process I was assisted by others who measured the diameter of the rope at my request and measured the lengthwise distance from the terminal fitting at the point where I was making observations and taking notes. By measuring the diameter, in several directions, we were able to verify that the wire rope had retained its roundness and was not flattened. Measuring the lengthwise distance to the point of failure made it possible to calculate the location of failure on a reeving diagram.

In ordinary service, all wire ropes will begin to exhibit obvious signs of progressive deterioration from any one of three primary causes: *corrosion*, *abrasive wear*, or *fatigue* of individual wires, or from a combination of two or all three of these kinds of progressive deterioration, all of which are detectible by visual examination. These visible indicators are reliable. They have been established after more than a century of practice, and they are universally applied.

During my examination of the entire length I noted that the wire rope was in relatively good condition. Other than at the point of failure, the wire rope had very few broken exterior wires, little wear on the crowns of the exterior wires, and did not display recognizable evidence of corrosion.

My focus of attention next was drawn to the apparent point of failure where the wire rope had parted, causing the accident. This portion of the wire rope exhibited two distinctive appearances:

[a] the strands appeared to have parted in a sequence; first a single strand, then two more together, and lastly the remaining three together.

[b] broken wires in the parted strands showed a mixture of necked-down or cup-and-cone type breaks, together with breaks that were more squared, and the strands were somewhat spiraled or curled probably due to some form of severe mechanical deformation at the time of, or instantly prior to, the failure.

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This kind of failure is representative of a well-known and unfortunately common kind of wire rope abuse, sometimes known as the "jumped sheave condition", although it can also be caused by other similar forms of service abuse involving small radius bending, any of which will result in a tension failure of the wire rope at a load level dangerously below the rated load.

Conclusions

[1] The wire rope I examined October 8, 2003 was for the most part in relatively good condition, and was lubricated properly. Based upon my review of the documents and testimony of the case, and considering that the wire rope had been laid out for inspection by a qualified person prior to installation, followed by the verification proof load test, and given the fact that a destructive tensile test performed on a sample of the wire rope December 21, 2000 showed that the wire rope had ample strength, I was able to conclude the failure of the wire rope most probably was *not* the result of any kind of recognizable progressive deterioration in ordinary service prior to the accident, and that the accident was *not* likely to have been caused by any of the conventional factors, including gross physical damage, that are ordinarily detectable during any routine visual examination by a qualified person.

[2] The wire rope I examined October 8, 2003 appeared to have suffered catastrophic failure caused by extreme tension overload while being subjected to abnormal bending conditions such as those created when the wire rope is no longer adequately supported by the groove of a sheave. It was my understanding that the operating crew were, at the time of the accident, deliberately using the crane in an extreme configuration with the safety limit controls deactivated. Although I did not actually examine the crane itself, I have certain knowledge, derived from 48 years experience in the wire rope industry, that exactly this kind of unsafe operating malpractice can lead to conditions that will cause a sudden and unexpected failure of any wire rope, even a new and unused wire rope. The post-accident appearance of the failed wire rope supports this conclusion.

Respectfully submitted,

Donald Sayenga, President
The Cardon Management Group